# HIGH STRENGTH GLASS FIBERS DEVELOPMENT PROGRAM

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SUMMARY

Thus far, our efforts have been entirely on the design and construction of equipment and facilities. The general process design calls for the drawing of a single glass monofilament from molten glass produced in an electrically heated furnace. The monofilament is attenuated to the desired diameter, coated with a plastic resin which acts as a protector and lubricant, and then wound on a drum for storage and eventual rewinding into a test ring structure. This much of the process is to be conducted in a controlled atmosphere to minimize corrosion of the glass filament by water vapor. We shall attempt to measure the tensile strength of the newly formed monofilament before and after coating by the resin as well as the strength of filament wound test rings made from the coated fiber.

During this early phase of the program most attention has been placed upon those portions of the equipment which seemed to require the longest lead time in building or obtaining purchased parts. These include primarily the spooler for drawing the fiber, the furnace and the environmental control chamber. A report of progress in these specific areas and others is given in the following pages.

## DETAILED PROGRESS DURING REPORTING PERIOD

### Spooler

We have completed the spooler design and our shop is now in the process of building the equipment. This piece of apparatus provides for winding glass fiber at linear speeds varying from 0 to 10,000 fpm onto 12" diameter spools which are traversed slowly past a stationary guide in order to lay down a single wrap of glass filament over the spool surface. This single layer of filament is calculated to be somewhat more than enough to wind one test ring on a 4" diameter mandrel. Since it is desirable to make more than one test ring from the glass produced under a given set of process conditions, the spooler equipment includes provisions for changing the windup from one spool to another without interruption of the glass drawing operation. This is accomplished by having two spools at opposite ends of a rotating turntable so that when one spool is completely filled, the next spool can be rotated into position to pick up the glass fiber. This change can be repeated as often as desired by simply removing a full spool and replacing with an empty one while it is not in the winding position.

### Furnace

The furnace design has been completed and materials have been ordered. A small platinum-rhodium alloy crucible with a 0.040" hole in the bottom contains the glass and is heated by resistance wires of another platinum-rhodium alloy which are wound on a surrounding ceramic sleeve. Insulation of zirconia and alumina is expected to reduce the heat loss from the furance to the neighborhood of 500 to 700 watts. The J. Bishop Company is fabricating the platinum crucible and supplying the platinum resistance wire, while the ceramic engineering component of G.E.'s General Engineering Laboratory will build the furnace.

Environmental Control

The three principal aims of the environmental control system are:

1. Production of an extremely low humidity atmosphere surrounding the process before the drawing of fibers is commenced and throughout production.
2. Maintenance of a slight positive pressure of inert gas to prevent re-entry of oxygen and water vapor.
3. Control of the solvent vapor pressure in the atmosphere if solution coating of the fiber is carried out in order to achieve rapid drying of the coating on the moving fiber. Two principal systems are being considered for this application. One is the conventional dry-box technique whereby the process is enclosed in a structure which conforms more or less to the shape of the equipment itself. In this type, access to the equipment is by means of armholes fitted with rubber gloves, which would be located at convenient

points as nearly as possible but would give limited access. The other design calls for total enclosure of equipment and operators in a rigid or non-rigid semi-sealed space which would be considerably larger than the dry-box type. This latter system has the advantage of offering unlimited access to the equipment and of being potentially cheaper to build. It does have the possible disadvantage of requiring personnel to be equipped with oxygen or air-breathing apparatus while working inside the enclosed space. In view of the fact that the equipment which would need attention or adjustment during a run will itself occupy a space approximately 3'x4'x8' high, it appears that the total enclosure system is most likely the better approach. Cost comparisons are now being obtained for building both the rigid and non-rigid total enclosures versus the dry-box type.

Coater and Drier

A mechanism for applying a resin coating to the newly drawn fiber has been designed and initially proven out in the laboratory. The objective of this apparatus is to apply the coating in the liquid phase without contacting the fiber with any solid material. This requirement is based on present knowledge of the detrimental effects on newly formed fibers of glass and silica by even the slightest contact with solid material. Our apparatus will consist of two counterrotating rollers, set a small distance apart, and between which the fiber passes in a downward vertical direction. The surface of the rollers is covered with a thin sponge-like material which picks up the resin solution from a dip tank and carries it to the fiber area where a portion of the solution is squeezed out by pressure rollers to form a pool of resin solution surrounding the moving fiber. The tendency of the solution to drop out of the fiber coating area by the force of gravity is counteracted by the rotation of the rollers and viscosity of the solution. In this way an excess of resin solution is prevented from running down the fiber and causing a very heavy build-up of resin, which is undesirable.

Calculations have indicated that it should be possible to dry the solvent from the resin coated fiber while it is traveling at the rate of 5,000 fpm by allowing it to pass through a tubular heater approximately 12" long if the temperature is in the neighborhood of 1,000°C.

<u>Test Ring Winder</u>

Design of the test ring winder is completed and parts are now being made. The spooler apparatus is used to pay off the fiber at a selected constant speed while a small torque motor turns the mandrel and maintains a certain small tension in the fiber as it is wound into the ring and during initial gelation of the resin binder. If the total enclosure system of atmospheric control is adopted (see above) this ring winding operation could be conducted within the environmental chamber also.

Test Equipment

A device for measuring tensile strength of single filaments is available at the General Electric Research Laboratory. We are planning to use this equipment to measure fiber strength before and after coating with resin.

For testing completed rings, we expect to use the NOL hydraulic ring tester. We have a set of blueprints from the Naval Ordnance Laboratory which will require some modifications to suit our ring size. These design changes will be accomplished in the next week and the work placed in the shop immediately thereafter.

## FUTURE WORK

During the next month, most of our work will consist of following up the construction of equipment, trying out the individual components and installing them in place in the environmental chamber. We should expect that actual drawing of glass fiber should begin about the third week of November.